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REQUEST FOR FILING A PROVISIONAL PATENT APPLICATION

Mail Stop Provisional Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

1. This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 C.F.R. 1.53(c).

2. The name and address of the inventors are:

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3. The title of the invention is: RESTORING DAMAGED RAIL SEATS LOCATED ON CONCRETE RAIL TIES

4. Direct all telephone calls to Jerome S. Marger, Registration No. 26,480, at (503) 222-3613 and send all correspondence to:

Customer No. 20575

Marger Johnson & McCollom, P.C.
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5. The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government. No

6. Enclosed are the following documents:
   ☒ Specification (pages 7); Drawings (1 sheet);

7. PTO Form 2038 authorizing credit card payment for the $160 (large entity) fees is enclosed.

8. The Commissioner is hereby authorized to charge any additional fees which may be required in connection with the filing of this application, or credit any overpayment, to Account No. 13-1703. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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RESTORING DAMAGED RAIL SEATS LOCATED ON CONCRETE RAIL TIES

BACKGROUND OF THE INVENTION

This invention is directed to methods and materials for restoring damaged rail seats located on concrete rail ties.

Conventionally, rails are held to rail ties by rail clips or fasteners that bear down on the rail flange. A rail seat insulates the rail from the rail ties. The rail seat can be fabricated of an elastomeric material such as rubber, polyurethane, ethyl vinyl acetate or high-density polyethylene

U.S. 5,173,222 ("US '222"), which is incorporated herein by reference, relates to a method and apparatus for repairing damaged concrete rail ties. Concrete rail ties have been found to be prone to wear particularly in sandy and wet locations or on steep grades where the locomotives use sand for traction. US '222 explains the cause of this wear. US '222 provides a method and apparatus for repairing rail tie damage utilizing an abrasion resistant composition and an abrasion plate as described therein.

As shown in the drawings of US '222, a rail seat 4 is disposed on a rail tie 1. The tie 1 is surrounded by ballast 2. The rail seat 4 is defined by the edges of the rail tie 1 and the rail clamp shoulders 3, which are embedded in the concrete tie 1 and adapted to hold the rail clamps (not shown) that bear down on the flange of the rail (not shown). The damaged rail seat is repaired by filling the worn recess 5 to receive a rail seat epoxy composition. An abrasion plate 6 can be bonded to the repaired rail seat.

US '222 identifies two problems. First, abraded ties need to be repaired quickly enough to limit hold up of train traffic to an acceptable time. Second, badly abraded rail seats need to be restored to their original dimensions.

The paste of US '222 employs an abrasion resistant material and a curable epoxy resin material. This epoxy resin is used for repairing damaged rail seats and also for reducing further abrasion. However, when applied in a relatively thin layer, the cure time can take 12 to 36 hours at typical ambient temperatures. This is completely unacceptable from a train operator's point of view.

If the trains are run even slowly over the freshly repaired rail seats, and if the epoxy is still in a plastic state, it will run-off. This will disrupt the true level of the rail seat, causing cavities to form in the rail set material which results in improper bonding to the abrasion plate. All of these factors will lead to subsequent failure of the rail seat.

US '222 overcomes these problems by providing a method of repairing a rail tie comprising applying an abrasion resistant composition which includes a curable epoxy binder to the eroded area of the rail tie, pressing the composition into place, and then heating the applied composition for a period sufficient to cure the epoxy binder. The rail plate can be placed on to the rail seat over the area to be repaired so that it becomes bonded using the epoxy binder repair composition to the rail tie with the application of heat and pressure using the hot box device 10 described in detail in US '222.

DESCRIPTION OF THE INVENTION

It has now been determined that when epoxy resins are used to repair a rail tie seat the following problems will result:

1. Conducting the rail tie repair using heat and pressure is a problem since this restoration method is difficult to perform in the field by laborers who are employed for this purpose.
2. Curing an epoxy resin over a wide range of humidities, temperatures and pressures is difficult to implement. Therefore, forming an effective rail tie seat in a commercial time frame is hard to consistently accomplish.
3. Pre-catalyzed mercaptan-based epoxy hardeners are commonly required in epoxy formulations, in order for these products to cure under cold conditions. These

mercaptan-based hardeners have a very obnoxious odor and workers often complain of becoming nauseous when working with these products

4. Repairing a rail tie with an epoxy resin does not result in a refurbished product wherein superior performance under dynamic operating condition is maintained.
5. The use of an epoxy resin does not result in a rail tie that exhibits a high level of durability under load while maintaining the gauge of a rail assembly.
6. The use of an epoxy resin does not result in a rail tie that exhibits a high level of fracture resistance under load while maintaining the gauge of a rail assembly.
7. The high viscosity of the epoxy resin makes handling more complicated when it is dispensed, particularly in the field.

It has now been determined regarding the present invention that when polyurea, polyurethane and polyurea/polyurethane hybrid polymers ("PUR") are used to repair a rail tie seat the following advantages will result:

1. Conducting the rail tie repair does not require the use of heat and pressure. Accordingly, this restoration method is more easily performed in the field by laborers who are employed for this purpose. The PUR rail seat has an extremely short Gel Time, preferably a substantially instantaneous Gel Time. This allows for placement of the rail seat components on the repair site without run-off occurring. The Set Time of the PUR is also sufficient to permit contouring of the rail seat in situ in the repair area using application techniques that do not require the use a heating apparatus.
2. Curing a PUR rail seat can be accomplished over a wide range of humidities, temperatures and pressures. Therefore, forming an effective rail tie seat in a commercial time frame can be consistently accomplished.
3. There is no obnoxious odor with a PUR and the same formulation can be cured under cold and warm conditions.
4. Repairing a rail tie with a PUR rail seat results in a refurbished product wherein superior performance under dynamic operating condition is maintained.
5. The use of a PUR rail seat produces a rail tie, which exhibits a high level of durability under load while maintaining the gauge of a rail assembly. The use of

PUR rail seat provides an increased percent elongation value that results in improved material durability. The modulus of the PUR rail seat is high enough to resist compressive loading allowing for maintenance of the rail gauge of the rail assembly.

6. The use of a PUR rail seat forms a rail tie, which exhibits a high level of fracture resistance under load while maintaining the gauge of a rail assembly. This improved fracture resistance is evidenced by the presence of a higher level of mechanical properties, better SEM image analysis results, and an enhanced Griffith fracture analysis. For example, the tensile strength of the PUR rail seat is at least equivalent to epoxy resins used conventionally. The use of a PUR rail seat provides an increased percent elongation value that results in a higher fracture resistance. The modulus of the PUR rail seat is high enough to resist compressive loading allowing for maintenance of the rail gauge of the rail assembly.

7. The lowered viscosity of the PUR makes handling less complicated when it is dispensed, particularly in the field.

PUR that are particularly useful in this invention are prepared from various combinations of amine terminated and hydroxyl-terminated resins that are reacted with an isocyanate material. A preferred PUR formulation and method of production which can be employed in this invention, and which was the PUR in the adhesion testing shown in Table 1, is as follows:

Table 1

Material Name	Description	Type	Wt. %
LHT-240	700 MW polyether tri-functional polyol	polyol	26.53%
30-56/LG-56	3000 MW polyether tri-functional polyol	polyol	13.22%
PPG-425	424 MW polyether diol	polyol	12.62%
Vestamine IPD	Isophorone diamine	chain extender	1.67%
EPI-Cure 3271	Diethylene triamine	chain extender	0.41%
2-Ethyl-1,3-Hexanediol	2-Ethyl-1,3-Hexanediol	chain extender	7.80%
Butyl Benzyl Phthalate	Butyl Benzyl Phthalate	plasticizer	4.37%
BYK-066N	BYK-066N	defoamer	0.50%

Mix at 750 RPM for 10 minutes while adding:

Aerosil 200	WACKER HDK 20 fumed silica	rheological modifier	2.07%
	Mix at 1100 RPM for 20 minutes while adding:		
MICRONA 7	MICRONA 7	calcium carbonate filler	28.02%
PURMOL 3ST SIEVE	Molecular sieve	water absorbant	2.56%
WV-90-S	WV-90-S	metal carboxylate catalyst	0.14%
WV-50-S	WV-50-S	metal carboxylate catalyst	0.08%
	Totals:		100.00%

Other preferred performance properties for the PUR materials of this invention are a Shore D (24 hr.) Hardness of at least 65, and the Maintenance of Rail Tie Properties at 140 degrees F.

Table 2-Summary of Adhesion Testing-Mode of Failure (%)

	Pull force(psi)	Concrete	Cohesive	Adhesive
Epoxy on a dry concrete block	233	81	19	0
Epoxy on a wet concrete block	60	9	3	88
PUR on a dry concrete block	400	100	0	0
PUR on a wet concrete block	107	0	100	0

The preferred modes of failure are concrete (best) > cohesive > adhesive (worst). Thus, as evidence by the above data, the PUR material has better adhesion than the epoxy material (on both wet and dry concrete).

Difference between the PUR materials and the traditional epoxy based materials that are designed for the repair of abraded concrete rail-seats have been made by examining the mechanical data, Griffith fracture criteria, performance criteria, and SEM imaging. More specifically, SEM imaging is used to establish the local defect size for the performance of Griffith fracture strength calculations.

In a visual analysis of the PUR and epoxy materials, respectively, the direct evaluation of fracture modes was made using a JOEL 6400 field emission scanning electron microscope. A prototype for the above-described PUR material was compared to a typical epoxy material using cryogenic fracture techniques.

Analysis of the materials was performed in accordance with the descriptions of fracture modes in the text Polymer Microscopy (Second Edition; Sawyer and Grubb) contained in Chapter Four – Specimen Preparation Methods. Specifically, section 4.8 of that text contains detailed descriptions and images of various yielding and fracture modes.

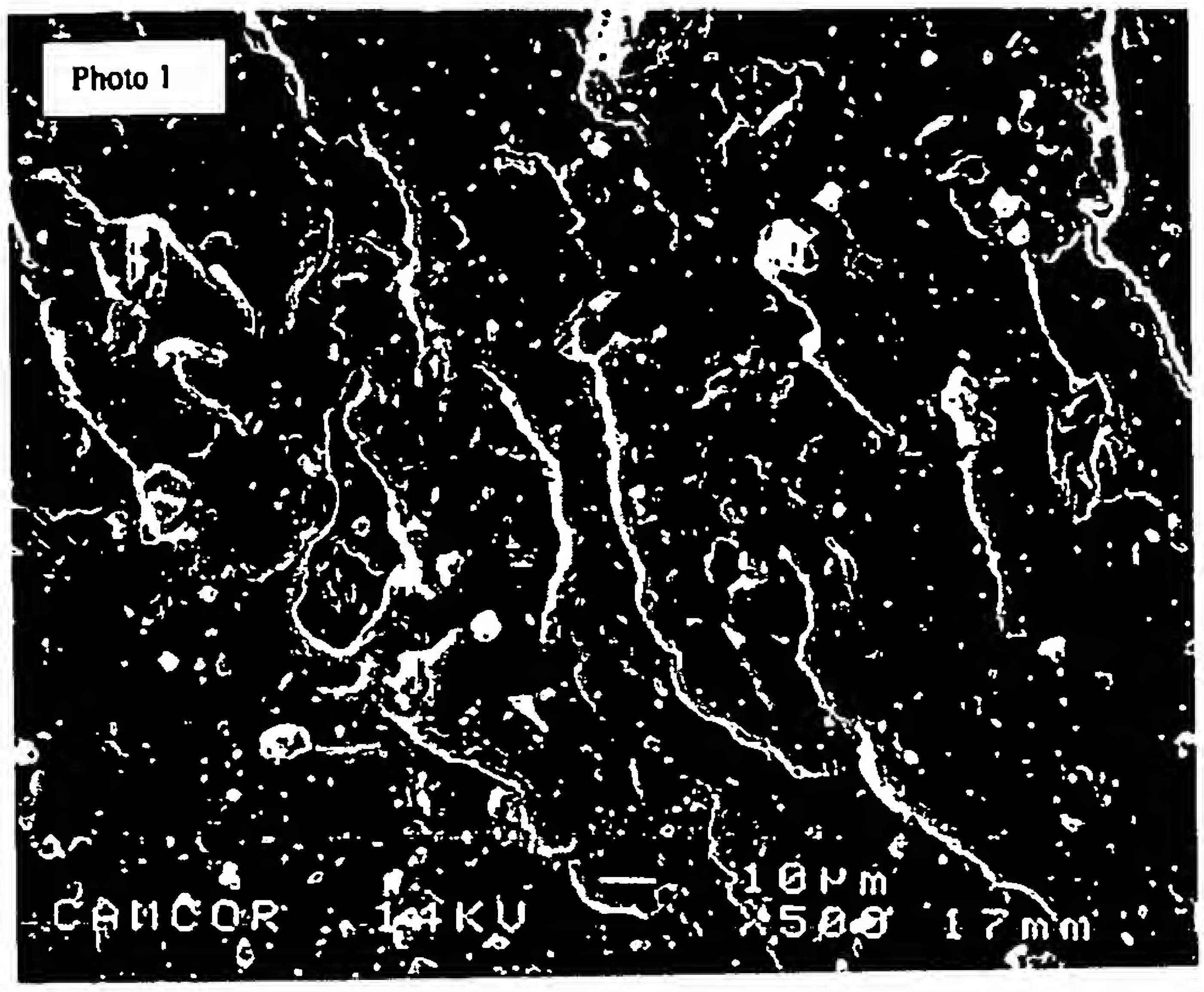
Photo 1 depicts the subject PUR system. It should be noted that the PUR material is intact with only a few yielding points and shear bands as depicted by the lines running vertically through the image. The polymer matrix is intact and several filler particles can be seen firmly imbedded in the matrix.

In contrast, Photo 2 depicts a typical epoxy material in which the polymer matrix has shattered. The matrix is not intact and numerous fracture zones are observed. The image is filled with jagged fracture peaks that contribute to a rather busy image. Support for this type of analysis can be further developed by examining the elongation properties of the materials under tensile loading (ASTM D 638). Typically, polymers with poor elongation properties (elongation > 5%) exhibit brittle fracture morphology.

With cryogenic fracture, the worst case scenario of material failure is explored. In the case of the PUR material, the matrix is capable of yielding without rampant cracking, thus contributing to higher fracture strengths. The epoxy material is incapable of yielding and it can be predicted that applied stress applied cyclically will eventually degrade that material. Failure analysis can be further compared using the techniques of Reifsnider and Case (Damage Tolerance and Durability of Material Systems).

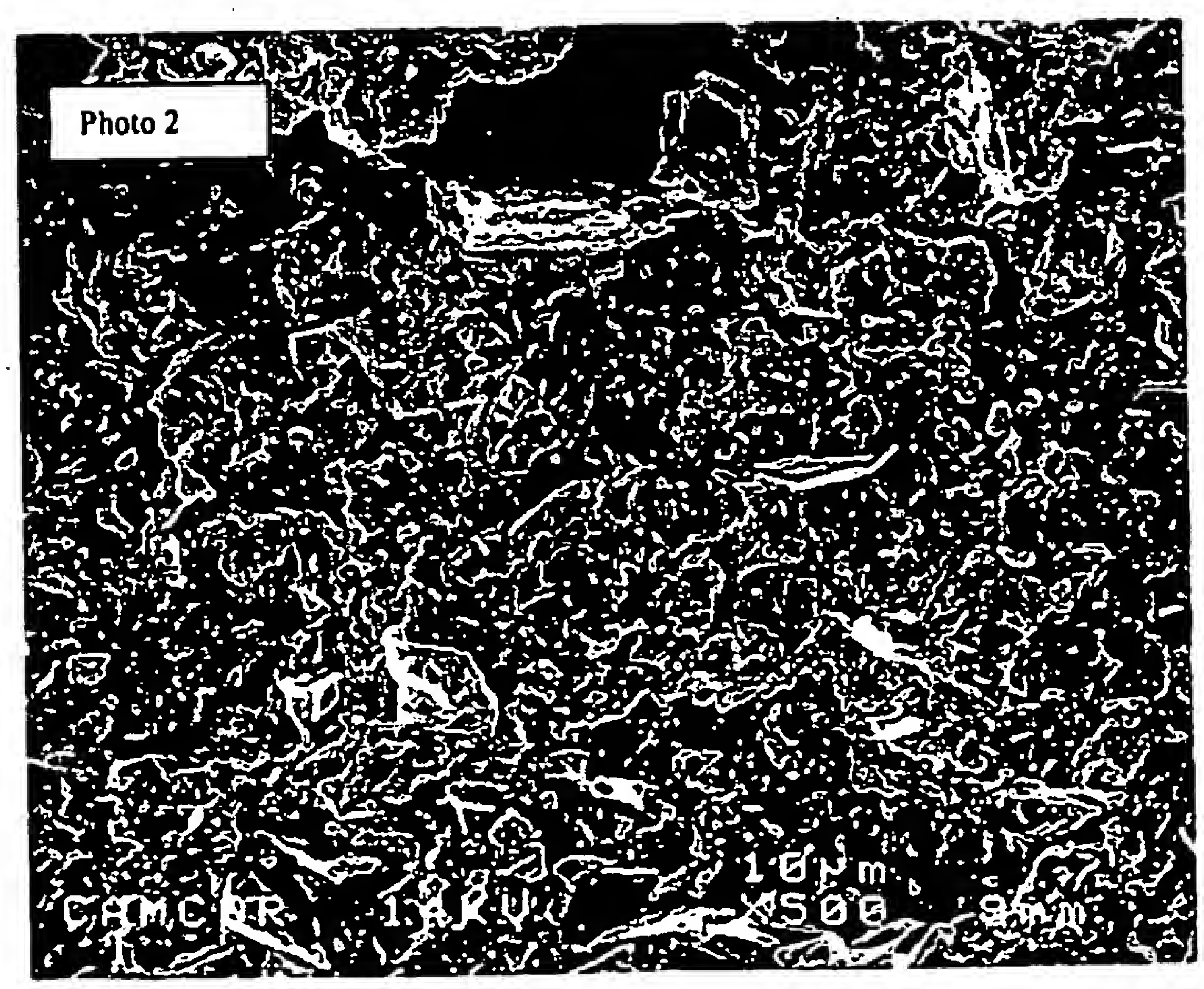
In summary, the SEM data clearly shows that the PUR material is superior for restoring damaged rails seats for use on concrete rail ties.

SEM Image: Urethane Based RSA



Field Emission SEM
University of Oregon EM Lab
Pictures by Paul Rogers

SEM Image: Epoxy Based RSA



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